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***Melanoderma microcarpum* gen. et sp. nov. (Basidiomycota)  
from China**BAO-KAI CUI<sup>1</sup>, CHANG-LIN ZHAO<sup>2</sup> & YU-CHENG DAI<sup>3\*</sup>*Institute of Microbiology, Beijing Forestry University, P.O. Box 61, Beijing 100083, China*CORRESPONDENCE TO \*: <sup>1</sup>baokaicui@yahoo.com.cn, <sup>2</sup>qiangzi717@163.com,✉ <sup>3\*</sup>yuchengd@yahoo.com

**ABSTRACT** — A new genus *Melanoderma* (Polyporales, Basidiomycota), collected from Hainan and Hunan Provinces in southern China, is proposed and typified by *M. microcarpum*. The new species is characterized by a perennial habit, pileate to effused-reflexed basidiocarps with a black crust at the pileal surface, small round pores, a dimittic hyphal system with clamped generative hyphae, dextrinoid and cyanophilous skeletal hyphae, cylindrical, thin-walled, non-amyloid, non-dextrinoid and acyanophilous basidiospores, the presence of apically encrusted cystidia, and lack of both hyphal pegs and dendrohyphidia. The new genus is compared with related genera of *Australoporus*, *Datronia*, *Dichomitus*, *Megasporoporia*, and *Perenniporia*. rDNA sequence analysis supports *Melanoderma* as a monophyletic clade that is closely related to *Vanderbylia*.

**KEY WORDS** — polypore, lignicolous fungi, poroid fungi, phylogeny, taxonomy

**Introduction**

During investigations on lignicolous and poroid fungi in China, three specimens were collected from Hainan and Hunan Provinces in southern China. These collections are microscopically similar to *Perenniporia* Murrill in having a dimittic hyphal system with clamped generative hyphae and dextrinoid and cyanophilous skeletal hyphae, but differ from *Perenniporia* in having thin-walled, non-dextrinoid and acyanophilous basidiospores. These collections may also be confused with species of *Australoporus* P.K. Buchanan & Ryvarden, *Datronia* Donk, *Dichomitus* D.A. Reid and *Megasporoporia* Ryvarden & J.E. Wright, but have distinct differences. Since the species cannot be accommodated in any known genera, we propose a new genus for these collections. To support our proposal as well as to evaluate the position of the new genus and related taxa, phylogenetic analysis was performed using 28S rDNA sequence data.

## Materials & methods

MORPHOLOGICAL STUDIES. — The studied specimens are deposited at the herbarium of Beijing Forestry University (BJFC) and the herbarium of Institute of Applied Ecology, Chinese Academy of Sciences (IFP). The microscopic procedure follows Cui et al. (2007). In presenting the variation in the size of the spores, 5% of measurements were excluded from each end of the range, and given in parentheses. In the text the following abbreviations are used: IKI = Melzer's reagent, IKI- = negative in Melzer's

TABLE 1. Species and sequences database accession numbers used in this study.

| SPECIES NAME  | SAMPLE NO. | GENBANK NO. |
|---|------------|-------------|
| <i>Abundisporus sclerosotus</i> Decock & Laurence   | MUCL 41438 | FJ393868    |
| <i>A. violaceus</i> (Wakel.) Ryvar den              | MUCL 38617 | FJ393867    |
| <i>Antrodia malicola</i> (Berk. & M.A. Curtis) Donk | TFRI 349   | EU232296    |
|   | FP 104329  | EU232297    |
| <i>Antrodiella americana</i> Ryvar den & Gilb.      | L 3468     | EU232269    |
|   | HHB 4100   | EU232270    |
| <i>Byssomerulius corium</i> (Pers.) Parmasto        | KHL 8593   | AY586640    |
| <i>Ceriporia reticulata</i> (Hoffm.) Domański       | KHL 11981  | EU118614    |
| <i>Donkioporia expansa</i> (Desm.) Kotl. & Pouzar   | MUCL 35116 | FJ393872    |
| <i>Fomitopsis pinicola</i> (Sw.) P. Karst.          | TFRI 513   | EU232290    |
| <i>Ganoderma applanatum</i> (Pers.) Pat.            | BCRC 36091 | EU232274    |
| <i>Gloeocystidiellum aspellum</i> Hjortstam         | LIN 625    | AF506432    |
| <i>G. porosum</i> (Berk. & M.A. Curtis) Donk        | FCUG 2661  | AF310099    |
|   | FCUG 2768  | AF310100    |
| <i>Melanoderma microcarpum</i>                      | DAI 9811   | HQ678175    |
|   | DAI 8116   | HQ678176    |
| <i>Perenniporia corticola</i> (Corner) Decock       | DAI 7330   | HQ654108    |
| <i>P. cystidiata</i> Y.C. Dai et al.                | CUI 8459   | HQ654113    |
| <i>P. detrita</i> (Berk.) Ryvar den                 | MUCL 42649 | FJ393866    |
| <i>P. martia</i> (Berk.) Ryvar den                  | CUI 7992   | HQ654114    |
|   | MUCL 41677 | FJ393859    |
|   | MUCL 41678 | FJ393860    |
| <i>P. medulla-panis</i> (Jacq.) Donk                | MUCL 43520 | FJ393875    |
|   | MUCL 49581 | FJ393876    |
| <i>P. truncatospora</i> (Lloyd) Ryvar den           | CUI 6987   | HQ654112    |
| <i>Perenniporiella chaquenia</i> Robledo & Decock   | MUCL 47648 | FJ393856    |
|   | MUCL 49758 | FJ393857    |
| <i>Phellinus alni</i> (Bondartsev) Parmasto         | TW 162     | AF311025    |
| <i>Pyrofomes demidoffii</i> (Lév.) Kotl. & Pouzar   | MUCL 41034 | FJ393873    |
| <i>Trametes elegans</i> (Spreng.) Fr.               | BCC 23750  | FJ372713    |
|   | BCC 23751  | FJ372714    |
| <i>Vanderbylia vicina</i> (Lloyd) D.A. Reid         | MUCL 44779 | FJ393862    |
| <i>Wrightoporia lenta</i> (Overh. & J. Lowe) Pouzar | KN 150311  | AF506489    |

reagent, KOH = 5% potassium hydroxide, CB = Cotton Blue, CB+ = cyanophilous, CB- = acyanophilous, L = mean spore length (arithmetic average of all spores), W = mean spore width (arithmetic average of all spores), Q = variation in the L/W ratios between the specimens studied, n = number of spores measured from given number of specimens. Sections were studied at magnification up to  $\times 1000$  using a Nikon Eclipse E 80i microscope and phase contrast illumination. Drawings were made with the aid of a drawing tube. Special colour terms follow Petersen (1996) and Anonymous (1969).

**MOLECULAR PROCEDURES AND PHYLOGENETIC ANALYSES.** — DNA was extracted from dried herbarium materials following the methods of Gardes & Bruns (1993) and Cui et al. (2008) with some modifications. In the study, nuclear ribosomal RNA genes were used to determine the phylogenetic position of the new species. Primers for PCR amplification were LROR and LR7 described by White et al. (1990). LSU sequences of the new taxa were deposited in GenBank, and used as references to blast against GenBank, similar sequences were downloaded, taxa used in the phylogenetic analyses are listed in TABLE 1. Maximum parsimony and Bayesian analysis were applied to the nLSU dataset. All characters were treated as unordered and equal weight. Maximum parsimony analysis (PAUP\* version 4.0) was used (Swofford 2002), based on strict heuristic searches with a tree-bisection reconnected (TBR) branch swapping algorithm, stepwise addition and collapse of branch if maximum length is zero. Bootstrap values were calculated from 1000 replicates. Bayesian analysis with MrBayes3.1.2 (Ronquist & Huelsenbeck 2003) implementing the Markov Chain Monte Carlo (MCMC) technique and parameters predetermined with MrMODELTEST2.3 was performed. When four simultaneous Markov chains were run with 100,000 generations, the average standard deviation of split frequencies was 0.00849.

## Taxonomy

### *Melanoderma* B.K. Cui & Y.C. Dai, gen. nov.

MYCOBANK MB 519872

*Carpophorum perenne*, *pileatum vel effuso-reflexum*, *pileatum nigrum*, *crustum*.  
*Contextum cremea bubalina*; *facies pororum nivea vel cremea*, *pori rotundi*. *Systema*  
*hypharum dimiticum*, *hyphae generatoriae fibulatae*, *hyphae skeletales dextrinoideae*;  
*cystidia pallida*, *ventricosa*, *incrustedata*. *Sporae hyalinae*, *cylindricae*, *IKI-*, *CB-*.

**TYPE SPECIES:** *Melanoderma microcarpum* B.K. Cui & Y.C. Dai

**ETYMOLOGY:** from Greek *melano-* (= black), *derma* (= skin); referring to the black crust at pileal surface.

Basidiocarps perennial, pileate to effused-reflexed, pileus circular to irregularly formed. Pileal surface black when fresh, colour unchanged when dry, concentrically zonate, glabrous; margin obtuse. Pore surface white when fresh, cream buff when dry; pores circular, dissepiments thick, entire. Context cream-buff, woody hard. Tubes cream-buff, woody hard, stratified. Hyphal system dimitic; generative hyphae bearing clamp connections; skeletal hyphae dextrinoid, CB+; tissue unchanged in KOH. Generative hyphae clamped, scanty, hyaline, thin-walled, unbranched; skeletal hyphae dominant, thick-walled to subsolid, usually branched, strongly interwoven. Cystidia clavate to ventricose,

hyaline, thin-walled, usually apically encrusted; cystidioles clavate, hyaline, thin-walled. Basidia clavate, with four sterigmata and a basal clamp connection; basidioles similar in shape to basidia, but slightly smaller. Rhomboid crystals frequently present in trama and hymenium. Basidiospores cylindrical, hyaline, thin-walled, smooth, IKI-, CB-.

The genus *Melanoderma* is characterized by a perennial growth habit, pileate to effused-reflexed basidiocarps with a black crust at pileal surface, a white to cream-buff pore surface, and small, round pores. A dimitic hyphal system with clamped generative hyphae, dextrinoid and cyanophilous skeletal hyphae, cylindrical, thin-walled, non-amyloid, non-dextrinoid and acyanophilous basidiospores, apically encrusted cystidia, and lack of hyphal pegs and dendrohyphidia also distinguish the genus.

***Melanoderma microcarpum* B.K. Cui & Y.C. Dai, sp. nov.**

FIG. 1

MYCOBANK MB 519873

*Carpophorum perenne*, pileatum vel effuso-reflexum. Contextum cremae bubalina; facies pororum nivea vel crema, pori rotundi, 7–9 per mm. Systema hypharum dimiticum, hyphae generatoriae fibulatae, hyphae skeletales dextrinoideae, hyphae skeletales contexti 1.5–5.7  $\mu\text{m}$ ; cystidia frequentia, pallida, ventricosa, incrustata. Sporae hyalinae, cylindricae, IKI-, CB-, 5.1–6.4  $\times$  1.9–2.7  $\mu\text{m}$ .

TYPE: China. Hunan Province, Yizhang County, Mangshan Forest park, on fallen angiosperm trunk, 25.VI.2007 Dai 8116 (holotype in BJFC; isotype in IFP).

ETYMOLOGY: from Greek *micro-* (= small), *-carpus* (= fruited); referring to the small basidiocarps.

**FRUITBODY** — Basidiocarps perennial, pileate to effuse-reflexed, narrowly attached, woody hard upon drying, without odour or taste, pileus circular to irregularly formed, projecting up to 1.6 cm, 1.5 cm broad and 5 mm thick at base. Pileal surface black when fresh and dry, concentrically zonate, glabrous; margin obtuse, cream-buff when juvenile, becoming black when mature. Pore surface white when fresh, cream to cream-buff when dry; pores distinctly circular, 7–9 per mm, dissepiments thick, entire. Context cream-buff, woody hard, up to 1 mm thick, upper surface with a black crust. Tubes cream-buff, woody hard, stratified, about 1 mm long in each layer.

**HYPHAL STRUCTURE** — Hyphal system dimitic; generative hyphae bearing clamp connections; skeletal hyphae dextrinoid, CB+; tissue unchanged in KOH.

**CONTEXT** — Generative hyphae scanty, hyaline, thin-walled, rarely branched, 1.5–3.6  $\mu\text{m}$  in diam; skeletal hyphae dominant, hyaline, thick-walled to subsolid, often branched, interwoven, 1.5–5.7  $\mu\text{m}$  in diam.

**TUBES** — Generative hyphae scanty, hyaline, thin-walled, unbranched, 1.2–3  $\mu\text{m}$  in diam; skeletal hyphae dominant, thick-walled to subsolid, usually branched, strongly interwoven, 1.2–5  $\mu\text{m}$  in diam. Cystidia clavate to ventricose,

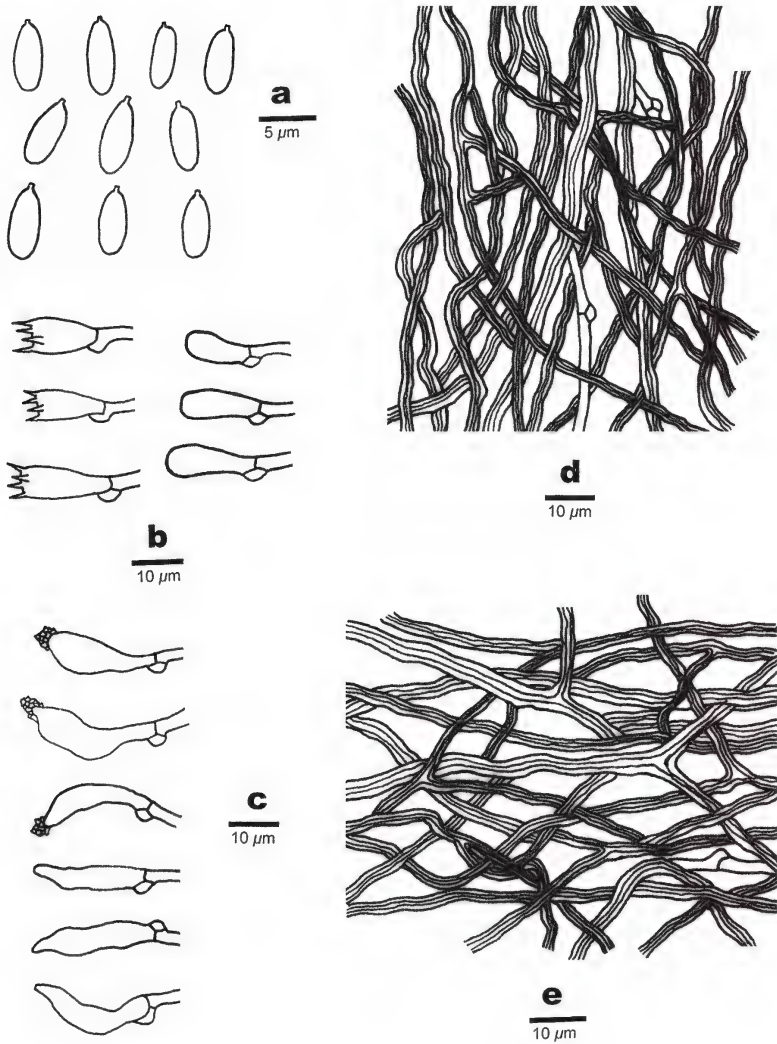


FIG. 1. Microscopic structures of *Melanoderma microcarpum* (drawn from the holotype). a: Basidiospores. b: Basidia and basidioles. c: Cystidia and cystidioles. d: Hyphae from tubes. e: Hyphae from context.

hyaline, thin-walled, usually apically encrusted,  $20\text{--}32 \times 4.8\text{--}7.6 \mu\text{m}$ ; cystidioles clavate, hyaline, thin-walled,  $17.6\text{--}24 \times 4\text{--}6.2 \mu\text{m}$ . Basidia clavate, with four sterigmata and a basal clamp connection,  $9.8\text{--}16 \times 5\text{--}6.5 \mu\text{m}$ ; basidioles similar

in shape to basidia, but slightly smaller. Rhomboid crystals frequently present in trama and hymenium.

**SPORES** — Basidiospores cylindrical, hyaline, thin-walled, smooth, IKI-, CB-, (5-)5.1–6.4(-7.2) × (1.8-)1.9–2.7(-3) μm, L = 5.92 μm, W = 2.28 μm, Q = 2.25–2.79 (n = 90/3).

**TYPE OF ROT** — White rot.

**ADDITIONAL SPECIMENS EXAMINED:** CHINA. HAI PROVINCE, Lingshui County, Diaoluoshan Forest Park, on fallen angiosperm trunk, 29.V.2008 *Dai 9811* (BJFC & IFP). Ledong County, Jianfengling Nature Reserve, on fallen angiosperm branch, 11.V.2009 *Cui 6582* (BJFC & IFP).

### Phylogeny

A primarily phylogenetic analysis on the position of the new species was done, and the parsimony consensus tree (FIG. 3) was made up based on the 28S rDNA sequences, in the tree, sequences of *Melanoderma microcarpum* were grouped together as a monophyletic cluster with strong support by Bayesian analysis and Maximum Parsimony analysis.

### Discussion

*Melanoderma microcarpum* is characterized by a perennial growth habit, pileate to effuse-reflexed basidiocarps with a distinct black crust at pileal surface, small and round pores, dimitic hyphal system with clamped generative hyphae, dextrinoid and cyanophilous skeletal hyphae, cylindrical, thin-walled, non-amyloid, non-dextrinoid and acyanophilous basidiospores, presence of apically encrusted cystidia, and lack of both hyphal pegs and dendrohyphidia.

*Melanoderma microcarpum* has dextrinoid and cyanophilous skeletal hyphae, which may be confused with species of *Perenniporia*. However, *Perenniporia* species have thick-walled, cyanophilous basidiospores (Dai et al. 2002), while *M. microcarpum* has thin-walled, acyanophilous basidiospores.

*Melanoderma microcarpum* is similar to *Megasporoporia* in sharing a dimitic hyphal system with clamped generative hyphae, dextrinoid and cyanophilous skeletal hyphae, cylindrical and thin-walled basidiospores, and rhomboid crystals in trama and hymenium. *Megasporoporia* species, however, usually have resupinate basidiocarps with big pores, large basidiospores, numerous hyphal pegs and dendrohyphidia, lack cystidia (Ryvarden et al. 1982, Dai & Wu 2004, Dai & Cui 2008, Du & Cui 2009). *Melanoderma microcarpum* has small pores (7–9 per mm), relatively small basidiospores, apically encrusted cystidia, and lacks hyphal pegs and dendrohyphidia. Furthermore, it has pileate basidiocarps with a black crust at the upper surface.

*Australoporus* has a dimitic hyphal system, dextrinoid skeletal hyphae, apically encrusted cystidia and cylindrical and thin-walled basidiospores, similar to features found in *Melanoderma*, but *Australoporus* has an unguulate basidiocarp without crust at pileal surface, pale pink to orange pore surface,



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